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THE PENNY POSTAGE SYSTEM.

The great interest that this system, recently put into operation in England, is calling forth both there and on the Continent, renders it somewhat surprising that so little has been said about it in our own country. We have every reason to believe that the peculiar advantages resulting from it might with suitable modifications in the plan, be secured on its adoption in the United States. It has been thought by some, that there are sufficient reasons for its failure in this country, however successful it may be in England. We propose at present, to make some remarks upon what we consider as defective or improper in the English system, and next to answer such objections to the experiment with us, as appear most worthy of consideration.

It is needless to describe all the details of Rowland Hill's penny postage bill, or its modified form now in operation, these are of course, familiar to our readers. The chief peculiarities are. Firstly—the reduction of the postage to a sum so small, one penny Sterling, as to greatly increase the number of letters circulated—the charge for letters to any part of the Kingdom being the same. Secondly—the adoption of such arrangements as shall insure the payment in advance of all letters. It is supposed that the increased revenue from the greater number of letters, from the abolition of the franking privilege (which has hitherto been very extensive,) and from the prevention of all loss by dead letters, will more than counterbalance the diminution in the charge.

Simple and beautiful as this plan is in its outline, it has not been easy to carry into practice until encumbered with certain provisions and arrangements, which in our humble opinion materially detract from the grand object and excellence of the system—its perfect simplicity. The weight of the letter is no longer confined to the former limit (one ounce) but is allowed to go to *sixteen* ounces, an additional charge being made for

each extra ounce, and hence the necessity of weighing every letter beyond a certain weight. This provision has called into being a whole host of inventions, under the name of letter balances, some of them simple and accurate enough in operation, but all troublesome, in that they have to be used at all. We hope, in the event of an experiment on this side the Atlantic, that the ingenuity of our mechanics may be spared this test.

In order to secure the advance payment of letters, an envelope is used bearing certain authorised marks, etc., which envelopes are sold wholesale to stationers or others, by the post office, at one penny a piece, and thus the revenue is received in cash, some time in advance, and in large sums at once, dispensing in this manner with the services of many clerks.

This envelope is a somewhat lozenge shaped piece of paper folding but once over the letter and meeting with its four points where the wafer is to be attached on the back. The face is nearly covered with a design, which as a work of art, has rather humble pretensions. This is covered by several stamps and letters or numbers which are to be frequently changed, and upon it is likewise the address. We saw one not long since, and turned it over frequently, and did not notice, what we afterwards remembered was to be wrought into the envelope, sundry silken lines in the substance of the paper, but which were said greatly to resemble ordinary faint lines—being perfectly straight. On returning to the specimen we had examined, sure enough, there they were but not easily to be distinguished from ordinary faint lines, save by the touch, which showed them to be in the body of the paper.

These changes in the system have introduced several curious, and some of them sufficiently ludicrous practices. The extension of the weight of letters to sixteen ounces, has brought strange things into the letter bags. We learn from an article in the Mechanics' Magazine, that among them, were *goosebery bushes*, *monstrous cucumbers*, small *models of steam engines* and *leeches*. It further seems to have been found necessary to caution the public by an official notice, to be careful in enclosing *glass bottles*, and that a post-man has been indicted for stealing a *watch* out of a *letter*. It is almost needless to say that any regulation allowing of or encouraging such fantastical enclosures, does not appear to have been contemplated in the original plan, and should be banished from any judicious trial of the system with us.

The sale of envelopes by stationers has led to the following device. A respectable dealer offers for sale by the quantity, envelopes at *three farthings* each, for which he has paid the post office *one penny apiece*—or at a loss of one-fourth. The secret is this, the inside of the envelope contains an advertisement of certain articles for sale by the same dealer. A more excellent plan for an advertisement could hardly be found, as at least two persons are almost sure to read each one. It would be profitable even to give them away when used as a medium for advertising.

The attentive consideration of the difficulties under which our transat-

lantic brethren labor in the introduction of this system, may prove useful to us when we enter upon the experiment—at any rate we can draw upon their experience for answers to any objections against the system itself.

In the first place the most reasonable objection appears to be this, that the great extent of country in the United States, will render the cost of transporting letters so great, that a reduced postage will not cover the expenses of the department. To this it may be answered that the average distance of transportation bears no sort of relation to the surface of country, and will not in fact greatly exceed that existing in Great Britain. We think we are within bounds when we say that more than three-fourths of the letters leaving the city of New York, go no farther than Boston, Albany, Philadelphia or Baltimore. It cannot be conceived that the expenses on these letters, even under the present system will amount to two cents apiece, and when the improved plan is introduced a large portion of the individual trouble bestowed upon each letter will be very greatly diminished. In this event and with the increased circulation we may reasonably consider that these three-fourths will more than pay the cost of the remaining fourth even were the average distance as far as New Orleans. At present it is expected that the profits on short and heavy routes, will pay for the longer and less profitable. Again, it is to be remembered that when the expense of marking, charging and collecting on each letter is entirely done away with, letters will approximate more nearly to common freight, and it will readily be acknowledged that the charge of two cents per letter, will pay well enough on short routes, to cover any deficits from those of excessive length. It has never been considered desirable that the post office department should more than pay its expenses—the idea of making it a source of revenue, is preposterous—we had almost said.

The method of securing payment in advance, is considered as liable to many objections, the opportunity for forgery being thought very great. There are also those who think, that the many who are ever more mindful of names than things, would find their feelings so shocked by the idea of a *stamp* as to oppose a system introducing *stamped paper* and to visit upon its authors condign punishment. We propose to avoid this difficulty by the use of the word "*Frank*," a term by which no *freeman's* prejudices need be excited.

The use of adhesive franks, as proposed on in the original plan, strikes us as preferable to the envelope now in use in England.

Whatever method is adopted, the danger of forgery is not so great as is imagined. There is much more danger of bank notes being imitated because these are worth more, and yet the loss by counterfeiting is very small. In the case in point, however, the immense practice acquired in handling letters would give such a facility in detecting impositions as to render any loss by them almost impossible. We all know with how much readiness a receiving teller will detect a counterfeit, and there is no reason why a still greater degree of expertness might not be attained in the post

office. The public will in all cases be safe from fraud by purchasing only from respectable dealers. In fact we consider the difficulty of deception and the certainty of detection to be so great, as to render the multiplication of checks unnecessary.

Another plan has occurred to us, by which the difficulty might be removed. Let there be issued a 2 cent silver coin, passable as ordinary currency, and let this coin be attached by wax, or otherwise to each letter when thrown into the box. It is obvious, that without any charge for preparing envelopes or franks, the department receives payment in advance, in actual money and all that remains to be done is to remove it from the letter when examined. We confess that there are some difficulties attendant upon this plan, but they are such as could soon be overcome. The coin might, indeed, be a 2½ cent piece, or a quarter dime. A friend at our elbow, holding up to us one of the English "adhesive stamps" suggests the immeasurable superiority of a genuine "specie, hard money" currency, to "shin plasters" of any kind.

We believe that we have answered the chief objections to the penny postage system—but we cannot conclude our remarks without adding one advantage to the many and obvious benefits so frequently canvassed. We allude to the moral of the system. It is calculated to extend and continue friendships which under the present high rates of postage, are suffered to languish; it will become the means of associating the citizens of our country in close fellowship, promoting kindly feeling and doing away with sectional prejudice—it is in fact, offering to many of our citizens, a new sense—the hitherto unattainable means of communicating with friends at a distance.

The larger portion of letters now circulated, are sent by business men; but the reduction of the expense, would encourage intercommunication between those who have no worse reasons and may be, greater abilities to render others benefit by their letters. The rich will write more, and the poor still more, in proportion to their present correspondence. We know that many in their utilitarian views of matters and things will be inclined to dispise, and perhaps ridicule this last argument, but if such there are, they may laugh as much as they please—we candidly confess ourselves philanthropic enough to rejoice at the thought of the pleasure that will be afforded to thousands of hearts, by the introduction into our country of the "*Penny postage system.*"

ERRATA.—In our last number, the notice of Bedwell's gauge is confused by several errors. Page 105, line 11 from bottom, for "air pressure gauge," read "air pump gauge;" line 8 from bottom, for "three inches," read "thirty-one inches."

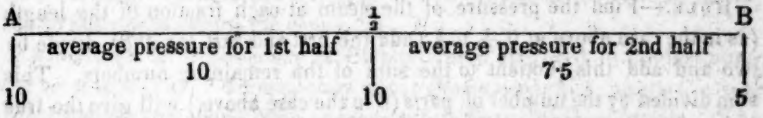
PENNSYLVANIA AND OHIO CROSS CUT CANAL.—The completion of this important work was celebrated with appropriate ceremonials on the 4th inst. by the citizens of Pennsylvania and Ohio. This canal runs from Beaver, Pa., on the Ohio river, to Akron, on the Ohio State Canal which connects Lake Erie with the Ohio river.

For the American Railroad Journal and Mechanics' Magazine.

MR. EDITOR:—In turning over several works on the steam engine, for the purpose of ascertaining the precise amount of power derived from using steam of any given pressure on the "cut off" or expansive principl e have been surprized at the meagre details on this point. The only calculation I have found, is in a paper on the Cornish engines, which has several times been alluded to in your Journal. This calculation, however, seems to me to be erroneous, and although the mistake is not very great, yet it is proper enough to extirpate all error from calculations on this important subject. It seems to me that the matter is very plain, and how a mistake can have occurred does not easily appear. Permit me to explain my views of the question, and if I should be wrong, no one would be more happy to have the error pointed out than myself.

Let us in the first place examine into the subject, and then look at the quotation referred to.

Suppose steam of 10 pounds enters the cylinder, and is cut off at half stroke. Required the average pressure for the whole stroke. The following diagram will represent the pressure of the steam at different parts of the stroke, supposing A and B to be the ends of the cylinder.



Thus the pressure is 10 pounds for the first half, and this same steam expanding to double its volume when it fills the cylinder, the pressure of 5 pounds is arrived at when the steam fills the whole cylinder, and only then, the average for the last half will therefore be 7·5 pounds, and the mean of the whole stroke $(10+7{\cdot}5)\frac{1}{2}=8{\cdot}75$ lbs. Now the calculation adopted in the paper mentioned above, and for all I know, the one generally used would be $(10+5)\frac{1}{2}=7{\cdot}5$ lbs. making a difference of one pound and a quarter or $12\frac{1}{2}$ per cent. of the original pressure.

Let us now turn to the paragraph above mentioned. It is as follows:

"Now supposing the admission of steam was cut off when the piston had travelled one-sixth of its stroke, the operation of its expansion, and the pressure at different stages, and mean pressure of the whole, will be seen by the following table.

	lbs. pres. per sq. in.
During $\frac{1}{6}$th of the stroke dense steam was admitted at a pressure of	17·25
At $\frac{2}{6}$th of the stroke the steam had expanded to twice its volume and the pressure was reduced to	8·62
At $\frac{3}{6}$th of the stroke, three times,	5·75
At $\frac{4}{6}$th of the stroke, four times,	4·31
At $\frac{5}{6}$th of the stroke, five times,	3·45
At $\frac{6}{6}$th of the stroke, six times,	2·87
	6)42·25
Mean pressure per square inch,	7·04

It might be supposed that the writer himself would have seen his mis-

take as he uses the word "During" and next "At," showing a perfectly correct statement but erroneous reasoning, therefrom. The diagram which follows will show the state of the case.

0	$\frac{1}{6}$	$\frac{2}{6}$	$\frac{3}{6}$	$\frac{4}{6}$	$\frac{5}{6}$	$\frac{6}{6}$
av. pres.	av. pres.	av. pres.	av. pres.	av. pres.	av. pres.	
17·25	12·93	7·18	5·03	3·88	3·16	
17·25	17·25	8·62	5·75	4·31	3·45	2·37

By taking the mean of these several average pressures, it will be found to be 8·24, giving 1·2 lb. more than the pressure calculated in the paper.

I feel the great necessity of caution, in pronouncing this to be an error, because it would appear from some remarks of the writer that Watt had made the same mistake, and he certainly would not be likely to fall into error. Not having access to his own calculations, however, I am inclined to think that he has been misquoted.

The true mode of calculating, then, is, to obtain the average pressure of each portion of the length of stroke, and then take the mean of the quantities thus obtained. The process at first appears rather complicated, but the following rule, it is believed will simplify it as much as possible.

Rule.—Find the pressure of the steam at each fraction of the length (as in the case above at 0, $\frac{1}{6}$, to $\frac{6}{6}$,) add the first and last together, divide by two and add this quotient to the sum of the remaining numbers. This sum divided by the number of parts (6 in the case above,) will give the true average.

The importance of a true expression of the power when steam is used expansively, renders it somewhat remarkable that no notice should before have been made of this error. As I said before, if any of your readers can prove that I am wrong I should be most happy to acknowledge myself so, if the true solution is given by any one else. II

To the Editors of the American Railroad Journal and Mechanics' Magazine.

It has long been known, that a fluid of any description running from an orifice in a vessel, whether at the side or the bottom, into the atmosphere, is more obstructed than it should be legitimately by the mere pressure of the latter. It also is known, that if this fluid thus issuing is made to pass through an abconic tube—the outer end being the largest, it will leave the vessel in greater abundance than it ought to do, pursuant to the laws of falling bodies. Newton made experiments upon those facts, but he did not perceive the cause. Nor has that cause ever been given. I have recently discovered it. Nor is it very occult. It is to be found in the *elasticity* of the atmosphere. I have made a drawing to demonstrate this, but could not stop there, and do what I considered to be justice to myself and the subject; for, in turning over the pages of the American and Franklin Journals of Science, I found many instances where the same principle was involved, while the writer of the article in which it was so, knew nothing about it. My remarks upon these articles extended my own to about twen-

ty pages, and too far for this Journal and perhaps too far any one. I am therefore under the painful necessity of leaving the dynamicians of the age to tell us how it is that the *elasticity* of the air opperates against the spouting fluid in the one case, and in favor of it in other.

It is said that the velocity of any wave is equal to that which a body would acquire in falling through half the depth of the fluid in which such wave is found, but I have not seen the demonstration, and do not succeed in perciving the truth of the proposition. I wish it could appear in some of our scientific Journals.

It is known that the first or perhaps the second tide after the syzygy is greater than is that which occurs at the time of this conjunction or opposition of the sun and moon; and in explanation of this phenomeny we are told in general terms that the tide we have one day was raised the day previous. But this is not *strictly* true. The expression conveys a wrong idea; but to show what is correct in this case would require more diagrams than would be suitable for this Journal. This point, then, I must leave to dynamicians.

It is said there is no lunar tide at the Sandwich Islands. Let us know for a certainty whether the fact is so or not—and then we shall be in season to attempt to assign the cause.

Alterations for the synopsy of Botany which appeared in the last number of this Journal. Immediately above *Nomastephanies* insert *Corticalutas*, dirca ; and above *Nomexogenes*, insert *Sacarinarbors*, maple. The Endogenas are thus arranged; 1st the *Palmates*, and 2nd the *Musates*, which are spathate; 3d the *Nomendogenas* which include all that have a corol distinct from the calyce; 4th the *Liliates* will embrace those except the orchidates whose calyce and corol are confounded; 5th the *Orchidates*, will consist of the labiates; 6th the *Cormocockles*, screwstem, and 7th *Typhates* have a spadica without a spathe, but they are easily distinguished from each other; 8th, the *Arumites* have a spadica and spathe; 9th, the *Helosites*, or belanophors; 10th, the *Juncaginates;* 11th, the *Fluvials* and 12th, the *Pistiates* are all easily distinguished from the others; and these groupes may be spoken of as primary ones without any confusion, because neither is included in any other one; and thus we shall have *sixty-five* classes of vegetals proper. And to the question, should it be asked, why we do not make every natural order of botanists a class, our answer is, we cannot distinguish them by any obvious character to the common observer. The *Ulmutes* and *Tiliates*, would be the next ones, that we should attempt to distinguish, but we leave them for the present.

Say of the Artocarpics, that they are *Apogynandrous* and sometimes *Alophytandrous.*

Of the Spermagonics, that they are occasionally Alophytandrous. This, remember is said of the plants. Of the Stamins, we should say, they are *Alophytous*, *Apogynous*, *Apogynautophytous*, etc. This last term you will say is long; but it is no more so than Monoecious-diclinous, for which it is

substituted; and besides, the old terms which you will perceive I have laid aside, are applicable not to the plant nor even to the stamins alone, but only to the stamins and pistils taken together as one entire group. By adopting these terms I have carried out the nomenclature which botanists have already adopted; so that stamins are now Hypogynous, Prigynous, Epigynous, Apogynous; and the plants are Syngynanders, Apogynanders, (polygamous) Allophytanders and Apogynautophytanders. This term is no longer, and more euphonous, than is unconstitutionality.

Say that the stamins of the Malvates and the anthers of the Composites are *Synemenous*, and that the Malvates themselves are *Synemenandrous* and the Composites *Synemenantherous*. The old terms are all a disgrace to botany, and an outrage upon the Greek language.

OLIVER SMITH.

For the American Railroad Journal and Mechanics' Magazine.

I have waited for several weeks, since the communication on page 4, in order to hear all that others might say on the subject of "Crank Motion." As there appears to be a cessation on their part I will proceed, and endeavor to sustain the positions taken in my former article, page 324.

From the communication page 4, it will be seen that the author has yielded the point in dispute and now grants that there is no loss from the crank except extra friction.

There would be no need of referring to his paper, except that from his peculiar style it might appear that I had made a gratuitous attack upon one who always thought with myself. I shall not however undertake to refute any of his positions since he allows the main point; but merely suggest a few questions for the reader's consideration, and at the same time request him to examine my remarks as well as the comments, in case the author should favor us with another critique.

1. Why is the author "particularly called upon" and "strictly required" to answer communications on the theory of the *Crank*, because he has written on *Locomotives?*

2. Why does he suppose his works on the locomotive to be the objects of attack when no one but himself has referred to them?

3. Why does he say respecting myself "which I presume he finds necessary to support the vagary of a perpetuum mobile into which he had sophisticated himself," when I used the acknowledged impossibility of a perpetual motion, to prove his views erroneous, as they led directly to this result?

4. Why does he call my expression "$\dot{p}$=P sec. d," a "profound absurdity," and propose as a substitute "p=P cos. d? Is he ready to maintain the accuracy of his expression when applied to the thrust of a rafter or an arch, and to say that as the roof or the arch flattens the thrust is diminished, and when the angle d (="the angle of departure of the rod from the line of the original direction of the power") becomes almost a right angle, and

consequently the rafters or the arch nearly horizontal, then (the force p= "the force in the direction of the rod," or in the case of a roof or an arch) the diagonal thrust becomes almost nothing?

5. Can he show "a more wonderful affair than even a perpetual motion?"

6. Can he show a "profound absurdity" in the conclusion that when the angle d is nearly a right angle, "the force upon [of?] the piston would be multiplied to an unlimited extent." Or in the case of an arch (supposing all the weight in the keystone to make the case precisely similar,) is it absurd to say that the thrust becomes infinitely great as the arch is infinitely near a straight line?

7. Can he show the necessity of "combining several connecting rods" to increase a force already granted to be unlimited from the use of a single one?

8. Can he show that a "power quite unlimited might be *created*" because the force becomes infinitely great when its virtual velocity becomes infinitely small?

9. Can he show that under these circumstances "an animalcule might be substituted for the gigantic power which men have hitherto found it necessary to employ?

10. Can he show that p is a maximum at the dead points, and in all other positions always less than P?

11. Can we call his unsupported objection to the proposition

$$V : v :: \text{sin. } c : R,$$ an argument?

12. Can he show the necessity of referring to *his* paper to prove that a passing remark in *mine* was "mere assertion," when I stated distinctly that "this practical demonstration is too long and intricate for the present article?"

13. Can he inform us, how, without "calculation" but from "purely numerical statements of the results of experiment," we can ascertain whether there be, or be not, a loss from the crank?

14. Can he inform us. what are the "reserved privileges" of an individual, who, when arguing a scientific point, breakes through the rules of debate, and resorts to personalities and harsh expressions? Or does he expect to cover his retreat from an untenable position, by using towards myself and others, such terms as "absurd estimate; fallacious reasoning from absurd premises; errant and gratuitous assertions; verbal sophistry; vagary of a perpetuum mobile, into which he has sophisticated himself; very little skill or very little caution; profound absurdity; more wonderful affair than even a perpetual motion; of course chimerical, and the result of incorrect analysis; castles airy; tilt Quixotic; tumble into a promiscuous chaos of cloud and vapor?"

15. Can he reconcile his present remark "that its effect." (*i. e.* the crank) "was included with the utmost precision in the item friction," with the whole tenor of his former communication, from which I need only extract the following. "For let it be observed that this resistance of an unloaded

engine is *incorrectly* named when designated *friction.* It is indeed a compound result, including within it the effect of the crank; and is in fact the friction proper to all the rubbing parts of an engine, increased in the *ratio of loss from crank motion?*

16. Finally.—Can he show that I have not put a fair construction on his expressions, or that there is any discrepancy between this paper and my former communication? In his own communication, can he show an argument that is not an error?

The next communication is on page 36.

In this the author by a different process arrives at the same point with myself and shows that there is no theoretical loss from the crank. It therefore requires no comment.

In the third communication, page 66, the author objects to my views. He says:

"If we could change a rotary motion into a straight motion without applying a straight motion we could accumulate power. But since this is impracticable, and since a rotary motion produced by a previous straight motion causes a *loss* of as much useful power as the change from a rotary motion into a straight motion will cause a *gain* of useful power, the loss will balance the gain during the action of the machine, and there can therefore be no accumulation of power; hence no chance of a perpetual motion."

If we cause the crank to revolve by being attached to a drum, and this drum to be moved by means of a cord acting on the circumference, and to which the power is applied, we convert a rectilinear into a circular motion without loss. If we then, by means of the crank convert this circular into a rectilinear motion, we gain power according to the above hypothesis. We have therefore a gain without a loss; and the effect must be greater than the cause, which is impossible.

Again. "The principle I contend for is, that when a body has received an impulse of motion, this impulse will continue to operate in the same direction unless the course of motion is checked" [changed?] "and if then the force of the impulse be not allowed to develope itself freely, the momentum of the impulse will lose some power."

I have substituted *changed* for "checked" which I presume has been used as its synonyme for if construed strictly it would be a *petitio principii,* since no one can deny but that if the motion be checked, there will be a loss.

Now I not only deny that there must necessarily be a loss when a rectilinear is converted into a circular motion, but I assert that the curve may be of any description, and even that the motion may be angular without a loss of power or momentum, or a consumption of the power of the diverting force.

If the diverting force be constant, the motion will be curved, but if intermitted it will be angular. It makes no difference whether this force act

internally by attraction as in the case of gravity or of a body attached to a string and revolving around a centre; or whether externally by refulsion as in the case of a surface of different directions whether curved or angular, supposing it to remain fixed.

For take the extreme case of a hard body striking a plane nearly at right angles; its new direction must be that of the plane, for the body not being elastic it has within itself no resilience that would cause it to leave the plane, and the plane itself being fixed, cannot throw it off. The angle formed by the course of the body would therefore be nearly a right angle, but still there would be no loss of power. For, whatever the force against the plane, it is inert since no motion is communicated, consequently the plane receives no momentum. Since power or momentum can not be absolutely lost, we must find it somewhere, and since the plane receives none, it must remain undiminished in the moving body. Thus, the plane effects this change without loss to the moving body. But the plane itself does not move, therefore no power is expended by the diverting force.

This case includes that of curves. In ordinary practice we cannot prove this to be strictly the case, for we cannot find resistances that are positively fixed, and without friction, nor bodies that will not alter their form. But in the case of the heavenly bodies these natural obstacles do not interfere, and in their undiminished average velocities we have a practical demonstration that the initial momentum is not lost by a change of direction.

Again: The anthor objects to the proportion.

$$V : v :: \sin c : R$$

and says, "It will be agreed on that the respective velocities of the prime mover, and of the crank pin, are as the spaces through which they have actually moved."

I can by no means agree to this proposition. When the prime mover has a uniform velocity the crank pin moves with every velocity from infinitely great, diminishing constantly to unity. This being the case, the average velocity of the pin must at every position of the pin, (in the first and third, while the reverse is the case in the second and fourth quadrant) have been greater than at the moment we would compare their respective velocities. These respective velocities are not as the spaces through which they have moved, but through which they are moving for an instant, and are constantly changing, and as I maintain are correctly expressed by the proportion to which the gentleman objects.

Refer to the diagram, page 326, last volume. The pin being at P, its direction for the moment is DP. Had its direction from the commencement been the same, it would have moved from D to P, while the power acting in parallel lines would have descended from D to A. Therefore,

$$V : v :: DA : DP \text{ or}$$
$$V : v :: \sin c : R$$

That the pin does not actually move from D to P is a matter of no consequence since it is not spaces but proportions that we are seeking.

Again, I can not grant as a legitimate conclusion from the above that "the following should also be right.

$$\text{Versin } c : \text{arc } c :: \sin c : R"$$

since neither the versin nor the arc have any relation to the proportion I have used, nor yet to the respective velocities; as I have already shown.

But what are we to understand from the remarks on this proportion taken in connexion with the two above it on the same page?

As I understand the gentleman he says the following is correct:

$$V : v :: \text{sin verse } c : \text{arc } c$$

but subsequently he says that "the verse sine can bear no definite relation to an arc." Does he then mean that the respective velocities of the prime mover and of the crank pin can have no definite relation to each other? This I think must be the conclusion.

But I deny the accuracy of the last proportion; for when V is constant v is infinitely great at the moment it has passed the dead point. Therefore the arc c must at times be infinitely greater than the ver sin c. As this is never the case the proportion can not be correct. Consequently the reductio ad absurdum fails for want of premises, and my positive demonstration remains untouched.

I thus come to the conclusion that whether the position I have taken respecting the crank, be true or false, nothing has yet appeared that convicts me of error.

Yours respectfully,

B. Aycrigg.

PARLIAMENTARY RULES.

In all deliberative assemblies, a presiding officer is found necessary to preserve order among the disputants and prevent their resorting to personalities and irritating expressions.

It appears to me that the same arrangement is necessary in a journal in which arguments are carried on in print. The editor should perform the duties of moderator, and all objectionable articles should be returned to their authors until so modified as to be strictly in accordance with parliamentary rules.

Error and truth are the only questions of importance to the public, and to them it makes no difference whether promulgated by a Newton or an idiot.

That one writer objects to the investigations of another is no ground of ill feeling between the individuals. The best mathematicians sometimes commit errors, and a "fool may now and then be right by chance." But whatever a writer may *feel*, I think that no one should be allowed to use such expressions as "absurd premises," "absurd estimate" "profound

absurdity," &c. &c. If he *can* let him *prove* an error, and if the error be really *absurd* the reader can apply the epithet without seeing it in print.

Yours respectfully,

B. Aycrigg.

In regard to the foregoing remarks we have a few words to say for ourselves. It is a delicate matter to interfere with the communications of correspondents, yet this would never deter us from doing our duty in expunging expressions evidently improper, but then the difficulty lies in defining wherein impropriety exists. In the case before us, however, the truth is, that relying upon the courtesy of the parties concerned we never bestowed that care upon the articles when received, which the present turn of the discussion shows to have been really necessary. We recollect with great pleasure one case, in which a timely arrest of a hasty but unwarranted personality, brought the parties to a mutual understanding, convinced those in error, and brought about a personal acquaintance.

There has always been a slight difference of opinion with the proprietors in regard to the line of demarcation, but none whatever as regards absolute personal abuse; if such has ever crept in, it has been by one of the thousand accidents by which, in the management of a periodical, things are said and done unintentionally, and sometimes without the knowledge of the conductors.

Col. Aycrigg deserves our thanks for keeping his temper after feeling himself agrieved, but we are very sorry that he or any one else who can maintain such a good natured bearing, should have been deterred from entering into a discussion which that very good nature might have softened into a friendly exchange of sentiments.

American Engines in England.—We are glad to learn that American mechanical genius is appreciated in England, and that for the immense amount of railroad iron which the United States has received from Great Britain, the latter country is receiving from the former, in part payment, many excellent locomotive steam engines for her own railroads. The subjoined is part of a letter from a friend in Liverpool, written on the 3d of June:

In answer to your inquiries as to the locomotives shipped to this country, by your enterprising citizen, William Norris, under contract with some of our railroad companies, I am happy to say that they have succeeded to admiration. Some delay arose in testing some of them, arising from the circumstance of his head engineer, or manager, on this side the water, having, on two occasions been detained on the continent, by Mr. Norris' business there, longer than he calculated on; and nothing could be done in the trials of the engines in his absence. Every thing has resulted very satisfactorily, and all his engines have been promptly paid for, except the last, which was shipped in April, and is of the largest class, which is now on trial—and his agent tells me that the trial is nearly completed to perfect satisfaction—and which the company will pay for in less than ten days. I am further informed that all of Mr. Norris's engines give perfect satisfaction, and that orders have recently been sent him for four additional ones.

RESISTANCE TO RAILWAY TRAINS.—*Dr. Lardner recently delivered a course of Lectures "On the resistance of railway trains, the effects of gradients, and the general economy of steam power."*

LECTURE I.

Dr. Lardner commenced by observing, that it was a strong example of the manner in which practical matters were conducted in this country, that they had been now ten years, with all the extraordinary effects of railways passing under their notice, stimulating their attention and calling up the wonder of all parts of Europe, and yet to this hour the general problem, the solution of which was the actual amount of resistance to railway trains, might be considered to remain, so far as the engineering profession was concerned, without solution.

It was not till a very recent period that, even on common roads, the amount of this resistance had been made the subject of inquiry. An instrument, had, however, been invented by Mr. M'Neil, the engineer, who had instituted experiments to ascertain the actual resistance on turnpike roads, which he had found to be about one thirtieth part of the load. Now the principle was equally applicable to common roads as to railways, that the resistance would be diminished in the proportion in which they enlarged the wheel; but when they increased the size, they also increased the weight, so that there was a practical limit to the diminishing of resistance in this manner. The average resistance which a load placed on a railway afforded to the tractive power, was intimately connected with the principle upon which railways themselves were constructed; and this connection had been largely acted upon by the legislature in inquiries concerning contested railway bills. It had been assumed in parliament that an engine might be expected to pull a load, with all the necessary expedition, up an inclined plane, provided that inclined plane offered not more than double the resistance which an engine had opposed to it on a level. That had been laid down and acted on in parliament as a species of standing order. The principle acted upon was, that the resistance upon a level would be about 9lbs. a ton, and, consequently, an inclination which resisted 1 in 250, was an inclination up which the engine might be expected to work with a full speed. Upon this principle the sections of all the railways in the country had been laid. But the fact was, that the resistance depended upon entirely different principles. In the inquiries which took place, no one ever hinted that the resistance depended upon the speed—no one suspected for a moment that there was more resistance at thirty miles an hour than at one mile an hour. He was quite sure that many would be perfectly astonished at this statement, but it was a fact established by abundant evidence, and innumerable experiments made by philosophers at different times and in different countries, that resistance depended upon friction, and did not depend upon speed; that so far as resistance to any degree depends upon the friction of the axles upon their bearings, or the rolling motion of the ties upon the road, it was demonstrable that the resistance was the same at all speeds whatever, whether twenty, thirty, forty, or fifty miles an hour. Never supposing that there was any other cause, they at once assumed that resistance, at all speeds, was either actually or nearly the same. This was the source of the error.

One of the standing orders of parliament was, that whenever a railway had a curve, with a radius of less than a mile. the committee must make a special report of such a curve, upon the supposition that it was attended with increased resistance or danger. The popular idea was, that when the wheels got to the curve, the outer flange of the wheel mounted upon the rail, by the conical form of the tyre, while the other fell from off the rail;

thus the one wheel acquired a diameter virtually greater than the other; that, therefore, one revolution of the outer wheel, having a virtually greater diamater, would carry it over a greater space than one revolution of the inner wheel; and that the two things would accommodate each other so that the outer wheel gets over a larger portion of the rail, while the inner wheel, being virtually smaller, gets over a smaller space, and that in this way the cone of the wheel accomplished the thing. Never was there a more consumate mechanical blunder. The fact was, the cone had nothing to do with the traversing of the carriage round the curve; and it was entirely the mechanical action of the flange pressing on the rails.

He had alluded to one or more circumstances connected with the practicable and probable speed likely to be attained on railways, and the means by which that speed might be attained. Since the great questions which had been agitated respecting the effect which an increased witdth of rails would have on railway transit, and the effect which very large drawing wheels, of great diameter, would have on certain railways, the question of very vastly increased speed had acquired considerable interest. Very recently, two experiments had been made, attended with most surprising results. One was the case of the Monmouth express. A despatch was carried from Twyford, to London on the Great Western railway, a distance of thirty miles, in thirty-five minutes. This distance was traversed very favorably, and being subject to less of those casual interruptions to which a longer trip would be liable, it was performed at the rate of six miles in seven minutes, or six-sevenths of a mile in one minute, or 360-7ths of a mile (very nearly 51$\frac{3}{7}$ miles,) an hour. He had experimented on speed very largely on most of the railways of the country, and he had never personally witnessed that speed. The evaporating power of those engines was enormous. Another performance, which he had ascertained since he arrived in this neighborhood, showed that great as the one just mentioned, they must not ascribe it to any peculiar circumstance attending the large engines and wide gauge of the Great Western railway. An express was despatched some time since from Liverpool to Birmingham, and its speed was stated in the papers. One engine, with its tender, went from Liverpool, or rather from the top of the tunnel at Edge Hill, to Birmingham, in two hours and thirty-five minutes. But he had inquired into the circumstances of that trip, and it appeared that the time the engine was actually in motion, after deducting a variety of stoppages, was only one hour and fifty minutes, in traversing ninety-seven miles. The feat on the Great Western was performed on a dead level, while, on the Grand Junction, the engine first encountered the Whiston incline, where the line rises 1 in 96 for a mile and a half; and after passing Crewe, it encountered a plane of three miles to the Madeley summit, rising 20 feet a mile, succeeded by another plane, for three miles more, rising 30 feet a mile; yet, with all these impediments, it performed the ninety-seven miles in one hour and fifty minutes, or 110 minutes; consequently the distance traversed in each minute was 97 divided by 110, or 52$\frac{10}{11}$, nearly 53 miles an hour--a speed which, he confessed, if he had not evidence of it, he could scarcely have believed to be within the bounds of mechanical possibility. The engine which performed this feat, had driving wheels of 5$\frac{1}{2}$ feet diameter; their circumference would be 17$\frac{1}{4}$ feet. Taking the speed at 53 miles an hour, it was within a very minute fraction of 80 feet in a second of time. This was not the greatest speed of the engine, but the average speed spread over 97 miles, and there could be but little doubt that it could have exceeded sixty miles an hour during a considerable portion of the distance. Dr. Lardner concluded by saying, "there was as yet nothing to satisfy us that a much greater speed was at-

tainable by the adoption of the very large scale or gauge of railway which had been thought desirable by those who were interested in the Great Western Line."

Lecture II.

In this lecture the Doctor directed attention to a remarkable line of distinction which existed between inclinations upon railways of different kinds. If, for instance, they had a gradient which would fall at the rate of one foot in a thousand, the train would not roll down, because the gravitation would be insufficient to overcome the mechanical resistance. But suppose the acclivity were increased, so that the gravitation would just balance the friction, that inclination would be what in mechanics was called the angle of repose. The amount of this inclination had been made the subject of much dispute; but it had been generally assumed that it had been at the rate of 1 in 250, or at the rate of about twenty feet in the mile. Any inclination greater than this would cause the train to move down spontaneously; and it had been assumed in railway investigations before committees of parliament, that the train, under such circumstances, would double its velocity every second of time. The inevitable conclusion to be drawn from this was, that if they had a steep inclined plane of sufficient length, the consequence would be an indefinite increase of speed, till they had actually acquired a velocity of 1000 miles an hour. Now, they would after this hardly credit the results which actual experiment gave. Nothing could be easier than the problem to determine the actual resistance from the motion of trains on railways, because it was a matter of easy mathematical calculation to predict what the velocity acquired at the end of the first minute would be, and, according to the rule laid down, that it would be twice as great at the end of the second minute, and so on. By comparing this with the velocity the train actually acquired, the comparison would furnish them with an easy clue. Upon this principle, Dr. Lardner had proceeded in a series of experiments made on the Whiston Plane, which has a fall of 1 in 96. They had four coaches, the gross weight of which was 15½ tons, and these coaches were propelled along the summit level to the brink of the plane, until a velocity of 29 miles an hour was given to them, and then the engine was detached, leaving them to move down. By means of stakes placed on the side of the line, they were enabled to register the length of time it took to descend every successive 110 yards. They commenced their descent from the summit of the plane at a velocity of nearly thirty miles an hour, which, in a very short space of time, increased to 31¼ miles an hour, and then they found that gravity could do no more for them. Instead of going at the frightful velocity anticipated by parliament, they found they got into the most uniform rate of motion at the third or fourth stake, after which there was no increase of velocity whatsoever; and at this uniform motion they continued to descend till they reached the end of the plane. They submitted this experiment to all possible tests, by increasing the weight of the carriages to 18 tons, but it only gave them an increased velocity at starting of 33¾ miles, the train descending at a uniform speed the remainder of the distance.

Upon these experiments Dr. Lardner proceeded to remark—"There is an important thing connected with this, which I will briefly explain to you. The force that moves the train down an inclined plane is, as you will see, the gravitation of the weight of the train down the plane. This gravitation would, until altogether balanced by some resisting force, acquire an accelerated motion. So long as the resistance to the descending train is less

than the gravitation down the plane, so long will the excess of gravitating force down the plane produce an acceleration of velocity, be it more or less. But as soon as the resistance becomes equal to the gravitating force, then there will no longer be any acceleration; the train will no longer acquire an increasing speed. On the other hand, it will not loose speed; if it did, then the inference would be, that the retarding force exceeded the gravitation; but they acquire an equilibrium, and as soon as the resisting force increases to that point that it is exactly equal to the gravitation, then the motion is uniform. The inference we deduced, therefore, was this:—that at $31\frac{6}{10}$ miles an hour, the gravitation of this train down the plane of 1 in 96, was equal to the resistance; in other words that the resistance to that speed was $\frac{1}{96}$ part of the weight. And you will see that a necessary consequence of this is, that a train of equal weight, placed on a level, and drawn along a level at the same speed of $31\frac{1}{4}$ miles an hour, the resistance which it would oppose to the moving power would be $\frac{1}{96}$ part of the whole load. This alone will show you the extent of the error which these experiments exposed; for the common notion before was, that the resistance in all cases was $\frac{1}{250}$ part of the load, about 9 lbs pr tn. whereas it appeared that it was in this case $\frac{1}{96}$ part of the load, or about 23 lbs pr tn. so that the engineer's estimate would be in error to the inconceivable extent of mistaking resistance of 23 lbs. for a resistance of 9lbs per ton."

Dr. Lardner stated that he had tried similar experiments on the plane of the Grand Junction Railway, which descends from Madeley towards Crewe, at the rate of 1 in 177 for three miles; afterwards descending at the rate of 1 in 265, followed by another descent of 1 in 330. The coaches loaded at 18 tons were moved down this plane in exactly the same way, the wind being fair, and they got a velocity of $21\frac{1}{4}$ miles an hour, and with this velocity they continued to descend the three planes. On making inquiries of the engineman, he found that the steam was never cut off in descending these planes, so that, instead of accelerating the engines at a dangergous speed, as was anticipated by the parliamentary committee, they were actually insufficient to propel them at a sufficient speed for the work of the road. The result of all the experiments he made on the Madeley plane was, that he never met with an instance of propelling trains down, with a fair wind, at a speed of more than 23 miles an hour. From a comparison of the experiments made at the Madeley and Whiston planes, Dr. Lardner said, "I made a calculation, from which it appears that in the first experiment of the two trains, that portion of the resistance which is due to friction amounted to 96 lbs. only, while that which is due to the atmosphere amounted 268 pounds. In the second experiment, with 18 tons, the portion of resistance due to mechanical causes amounts to 100lbs., while that which arises from the atmosphere amounts to 321 lbs., at only 33 miles an hour. One of the objections was, that the train was too light, and that no fair inference could be drawn from four carriages. We, therefore tried trains of six and eight carriages. Several experiments were made down very steep planes—that of Whiston being 1 in 96, and that of Sutton 1 in 89. In the first experiment of six carriages, the wind was against us. Down the plane of 1 in 89, we could not get more speed than $32\frac{1}{3}$ miles an hour. At this speed the resistance was equal to the gravitation. But with the wind favorable down the same plane, we got $37\frac{1}{2}$ miles an hour, and a mean of these two would be about 35 miles an hour. On the Whiston plane, 1 in 96, with the wind adverse to us, we only got $27\frac{3}{10}$, or nearly 28 miles an hour, but with the wind favorable, we got 34 miles an hour, the mean of these being about 31. In both these cases, both on the Sutton and Whiston planes, you see the evident effects of the wind. The mean of the two, in these cases, gives, on

a less steep plane, a less velocity than on a steeper plane the mean did in the other cases. It is remarkable, and very satisfactory in confirmation of the former experiment, that we had six carriages in a calm descending the Sutton plane, and what was our uniform speed? 35⅓ miles an hour, the atmosphere being calm. In two other cases down the same plane, with adverse wind, we got a speed of 32½ miles an hour; with favorable wind, 37½ miles, the mean of which is 35½ miles; so that in a calm we got a mean between the speed with a favorable, and that with an adverse wind. All these harmonies in the results are so many corroborations of the principle which they develope."

Lecture III.

In this lecture the Doctor explained a variety of experiments made on railways, in order to ascertain the source of resistance. He found that an enlarged temporary frontage constructed with boards, of probably double the magnitude of the ordinary front of the train, caused an increase of resistance. Seeing that the source of resistance, so far as the air was concerned, was not to be ascribed to the form or magnitude of the front, it next occurred to him to inquire whether it might not arise from the general magnitude of the train front, ends, top and all. An experiment was made to test this; a train of wagons was prepared with temporary sides and ends, so as to represent for all practical purposes, a train of carriages, which was moved from the summit of a series of inclined planes, by gravity, till it was brought to rest; it was next moved down with the high sides and ends laid flat on the platform of the wagons, and the result was very remarkable. The whole frontage of the latter, including the wheels and every thing, a complete transverse section of the wagons, measured 24 feet square, and with the sides and ends up, so as to present a cross section, it amounted to nearly 48 square feet. The uniform velocity attained on a plane of 1 in 177, without the sides up, was nearly 23 miles an hour; whereas, with the sides up, it was only 17 miles an hour; so that, as the resistance would be in proportion to the square of the velocity, other things being the same, there would be a very considersble difference, due to that difference of velocity. Then, at the foot of the second plane, while the sides were down, an undiminished velocity remained of 19½ miles an hour, whereas, with the sides up, it was reduced to 8½ miles an hour; so that a very extensive difference was produced. They would see at once, that this was a very decisive experiment to prove that the great source of resistance was to be found in the bulk, and not the mere section or the form, whether of the front or the back of a train; but simply in the general bulk of the body carried through the air. It was very likely to arise from the successive displacements of a quantity of the atmosphere equal to the bulk of the body; or still more probably, from the fact of the extensive sides of the train; and indeed there was little doubt that the magnitude of the sides had a very material influence; for, if they consider what is going on in the body of air extending from either side of a train of coaches, they would soon see what a mechanical power must be exercised upon it. Thus, when a train is moving rapidly, the moving power had not only to pull the train on, but it had to drag a succession of columns of air, at different velocities, one outside the other, to a considerable extent outside the train; and it did more, for it overcame their friction one upon the other; for as these columns of air were at different velocities, the one would be rubbing against the other; and all this the moving power had to encounter. This would go far to explain the great magnitude of resistance found, and its entire discordance with any thing previously suspected.

Dr. Lardner next proceeded to consider the practical bearings which the

experiments he had detailed would have on the construction of railways. From these experiments a two-fold fact was deducible: first, there was unquestionably a great amount of resistance, and secondly, this resistance had a material dependence on the velocity; it diminished in a very rapid proportion as the speed was diminished. If, therefore, by slackening the speed, they could relieve the engine from any considerable portion of the resistance opposed to it, they had at once a ground for throwing overboard all the objections which had been raised against sections of railways which had considerable gradients. It was asserted that the resistance was a resistance quite independent of the speed, and that its average amount was quite equal to the gravity down a plane with a fall of twenty feet a mile. Both propositions had proved to be false. The resistance was not constant; it depended on the speed, and its average amount was equal to a great deal more than twenty feet a mile. The gradient that represented the average resistance, instead of being twenty feet a mile, was probably fifty feet; and instead of having no power of limiting the speed they had a power to which there was scarcely a practical limit. The lecturer stated that he had been ridiculed for the opinion he had advanced before the committee of the House of Commons, that the Southampton railway section, of twenty feet to the mile, was as practically good as that of the Great Western, which was on a dead level. He had made that assertion on the ground that in the descent there would be as much advantage gained as disadvantage to be encountered in the ascent; and, except the inconvenience which would result from the inequality of speed, being at one time fast, and at another time slow, there would be no other inconvenience or disadvantage worth mentioning. And, therefore, he did contend, that it was an extremely improvident and unwise expenditure to lavish millions in cutting through elevations and filling up valleys by large embankments, and constructing tunnels and viaducts, and all the other expensive works, to obtain a dead level. Experiments had since been made, which proved the conclusions he had arrived at to be substantially correct. These experiments had been made by Mr. Wood, the engineer of the Liverpool and Manchester railway, on the Grand Junction line. A train of twelve carriages, each weighing five tons, was attached to the *Hecla* engine, the gross load being about 82 tons. This was started from Liverpool to Birmingham, under peculiarly favorable circumstances as regarded the calmness of the day and the state of the weather, the engine being allowed to do its own work, unassisted on the various inclines; the velocity of speed throughout the whole way from Liverpool to Birmingham and back again from Birmingham to Liverpool, was, of course, accurately ascertained, and if the theory which he had endeavored to develope was correct, they ought to find that the average speed in ascending and descending the inclinations would be nearly equal to the speed they obtained on level parts of the line. There were several planes along the line, and taking the steepest first, viz. 1 in 177, they ascended that plane at the uniform velocity of 22¼ miles an hour, and descended it at the rate of 41¼ miles an hour, the average being as nearly as possible, 31¾ in ascending and descending. The ascent and descent of the other gradients on the line gave the same, or very nearly the same, results—the average speed varying little from 31 miles an hour. There was a considerable portion of the line level, and the speed upon that portion was 31 miles, being just the same, allowing for inevitable small discrepancies, as the average speed upon the inclines up and down the line. The plain inference which Dr. Lardner drew from these experiments was this: that the trains between Liverpool and Birmingham performed their journeys in just as short a time as they would do if the line was a dead level from terminus to terminus. He, therefore, considered it unadvisable, to expend money in attaining very flat sec-

tions, gradients not exceeding thirty feet a mile being, in his opinion, practically as good as a flat and dead level.

Dr. Lardner next observed that it was inexpedient to lavish money in avoiding curves of a less radius than a mile as no danger could, he believed, attend a curve having a radius of half a mile, perhaps less. It was, likewise, apparent that it was useless to lavish capital on expedients for greatly diminishing friction; such, for instance, as the adoption of wheels of a large diameter, for it was clear that fricton afforded but an insignificant part of the sources of resistance, while, by increasing the bulk of the carriage, they gave a greater frontage, and increased the resistance from other causes. Further, observed Dr. Lardner, it seemed probable that they should not with practical trains attain, in the present state of mechanical science, those extraordinary speeds which they were accustomed to hope for some time since. It was not at all likely that they should ever move at the rate of a hundred miles an hour, for the resistance due to the velocity would increase in so enormous a proportion, that it would become an opponent too formidable for any available power to overcome; still less was it likely that those speeds would ever be obtained with profit. Upon this subject Dr. Lardner remarked, "In some experience of railway traveling, I have never witnessed a speed exceeding 45 miles an hour; I did once accomplish that speed with four coaches, but only for a short distance. Mr. Woods has told me, that he has himself gone 48 miles an hour; but that was not for any considerable distance. Let it be remembered that great speed might be obtained in this way. You may get an engine with plenty of steam; you may screw the safety valve down so as to get a surcharge of steam; you may put no load on the engine, so as to diminish the resistance; and you may run it down a gradually declining gradient till you exhaust all the steam in her boiler upon a falling gradient. Then, if all these things be done, if the rails be clean, and if a correct account be kept, then there will be no denying that great speed has been attained. But when we speak of great speeds, this experiment, the whole length of the Grand Junction railway and back, at the average rate of 31 miles an hour through the whole distance, with 12 coaches, was a very respectable performance indeed, in the present state of locomotive power."

LECTURE IV.

Dr. Lardner said there were two principles on which railways were generally constructed:—First, by departing as little as possible from the natural surface of the ground, and distributing the inclinations very generally and evenly over the whole length of the line, in which case such power was given to the engine, as to make it pull up the requisite loads with requisite speed. Others, on the contrary, proceeded on the principle of concentration, and instead of distributing the inclinations over the entire length, they threw them all into one place, as in the case of the Whiston and Sutton planes on the Liverpool and Manchester railway, and it followed, as a necessary consequence, that the engines which were adapted for working the greater part of such lines nearly on a level, could not easily draw the loads up the inclination, which must therefore be done by additional engines; but if it had been expedient to make the whole line with inclinations like those of the Whiston and Sutton planes, there would not have been the least difficulty in working it, and those planes would have been ascended with just as much speed as that part of the line was now traversed which was nearly level.

Dr. Lardner next proceeded to consider the source of the power of the engine, the manner in which it was produced, and the mode in which it was adapted to use. They should naturally suppose that an element in engine-making of such vital importance as the quantity of surface which

ought to be provided to receive the action of fire, in order to produce a given quantity of evaporation, ought to be known to engineers, but they would probably be surprised to find that even the best engineers were as ignorant of it as themselves. No two of them could agree, and they differed, not only in small quantities, but even as much as 100 per cent. Another thing of importance was the magnitude of the grate. Some held, that a square foot of grate per horse power was sufficient; some allowed more, and some less; but generally speaking, three quarters of a square foot was alllowed. In the application of fuel there was also considerable difference. It might be applied so as to produce considerable effect, or so as to produce comparatively little effect. In this consisted what was called the art of stoking; and in no place was this worse done, in no place did it need to be better done, than on board ships. The coals should be spread lightly upon the grate; and when in a state of incnadescence, the stoker should push it back, and lay on more coals. The first effect would be, that the coals first laid on would be coked. The gasses would be impelled forward by the draught; and as they passed the incandescent coal, they would be consumed, and no smoke would issue from the chimney, the smoke being the unconsumed part of the fuel. As soon as the coke at the back was consumed, the stoker should push back that in the front, and introduce a further quantity of fuel. This would make a common furnace, in fact a smoke consuming furnace, and there would be a uniform evaporation of steam. But was this the practice observed? By no means. Neither in marine boilers nor in land boilers had the stoker any idea of taking any such pains; he adopted, not the most efficient way, but the way most comfortable to himself. He proceeded in this way: he let the fire in the grate be nearly out, he then put in an enormous quantity of coal; the consequence was, the very instant this was laid on, there issued an enormous quantity of smoke, which might be frequently seen issuing from the chimney of a steamboat. That went on for some time, till at length the chimney got a little rest. This was nothing more than the effect of putting on fresh fuel; and the smoke continued till it was burned red, and it suited the stoker's pleasure and convenience to open the grate again. They paid their stokers sufficient wages, and made them do their work; and on the *Medea*, for instance, there was no smoke from the chimney at all. There was nothing new in this. Mr. Watt proposed it; and in his factory at Soho, smoke was never seen issuing from the chimney. The only effectual remedy which could be devised would be to feed the furnace by self-acting grates. One had been invented in which the grate was made circular, and it revolved. The feed of coal was placed in a hopper, and the coal passed through it like a funnel. The coal was put in that part of the grate furthest from the flue. This machine was kept in motion by the engine itself, so that to a furnace of this kind there was little necessity for the attendance of men at all.

REPORT, SURVEY AND ESTIMATES OF THE ATTICA AND BUFFALO RAILROAD, MADE TO THE COMMISSIONERS, JULY 1, 1840. By George Rich, *Engineer.*

GENTLEMEN:—I have the honor to submit the following statement of the examination made by me, (assisted by William G. Bullions, of Schenectada,) with a view to the construction of a railroad from the village of Attica, Genessee county, to the city of Buffalo.

The survey commenced on the table land in the centre of the road leading from Attica to Alexander, a little north of the furnace, and near the probable termination of lhe Tonawanda railroad, at a point that may be varied to suit the location of that road, and ended on Batavia street, near the court house, in the city of Buffalo.

Length of line from commencement to termination, 30 miles 180 feet.

Length of line from commencement to corporation line, 29 miles 1780 feet.

Height of summit above grade at commencement of survey, 86 feet.

Height of summit above grade at corporation line in Buffalo, 424 feet.

Height of grade in Attica, above Buffalo, 338 feet.

By Elisha Johnson's survey to Batavia.

Distance from Attica Mills to Batavia, 10 miles.

Height of Attica above Batavia, 73 feet.

As the present survey was commenced 1200 feet northwest of the Attica mills, I will, for an estimate of distance between Batavia and Buffalo, call it 10¼ miles, from the commencement of the present survey to Batavia.

Distance from Batavia to Attica,	10¼	miles.
" from Attica to Buffalo,	30	"
Whole distance from Batavia to Buffalo,	40¼	"

From Attica, the route takes a northwesterly direction, following the south side of the ravine to the summit, which is a little over two miles. As the greatest difficulty was to be apprehended on the whole route, between Attica and the summit, I will, before proceeding any farther westward, give the result of the different routes examined, between Attica and the summit, one on the south, and one on the north side of the ravine.

The summit may be reached by the south line, on a grade of $43\frac{19}{100}$ feet per mile, crossing the Tonawanda valley directly in the village of Attica; and at some considerable expense over the north route. For difference, see estimate.

The north line would not cross the Tonawanda valley, and would leave the village of Attica ¼ of a mile to the south of the line, and make a saving of half a mile in distance between Batavia and Buffalo. The grade is less upon this route, being $39\frac{74}{100}$ feet per mile, and not so expensive as the south route, as it avoids the heavy embankment across the Tonawanda valley.

The whole distance by this route, from Batavia to Buffalo, would be 39¾ miles, and the highest grade $39\frac{74}{100}$ feet per mile.

Radius of smallest curve on the north route, 2150 feet.

" " " on the south route, 1420 feet.

No other curve, upon either route, of a less radius than 4000 feet.

By a reference to the profile, it will be seen that the highest grades upon the route, are upon this two miles east of the summit—the highest a fraction under 44 feet per mile, and the lowest a fraction under 40 feet per mile. If the grades upon the Tonawanda road were any less than these, it would be necessaay to make a deep and expensive cut at the summit, to reduce the grade or abandon the enterprise entirely, as lower grades may be had by the direct route to Buffalo. If I am correctly informed, there are grades between Rochester and Batavia, on the Tonawanda road, ascending in the same direction, as high as 44 feet per mile. The same engines would probably run the whole distance from Rochester to Buffalo, and the engine that brought a train to Batavia, could take the same to the summit west of Attica.

I would not, therefore, recommend an expenditure of money beyond what would be necessary to bring the maximum grade to 40 feet per mile.

From the summit to Alden, a distance of 9 miles, is a descending grade, with the exception of one undulation passing from one valley into another, near Pratt's mill. Immediately at the summit, the line passes through a meadow, situated on a long roll or swell of land, upon which it is difficult to detect the highest ground, without an actual level, for many hundred feet;

making it very expensive to attempt a reduction of grade by a deep cut at the summit. The difficulty of disposing of the material would be another objection to a deep cut, as there is no embankment on either side of the summit to exhaust the material, within a reasonable distance.

From the summit, the line continues near a northwest course for about two miles, through a broad valley of cultivated fields, frequently crossing a small stream of from 3 to 4 feet between its banks, which winds along nearly in the direction of the line, and passes off in a northerly direction. The line curves a little to the west, near Thomas Cooley's, and rises over a swell or ridge of land to Peters' swail, crossing in its course a small stream called Murder creek, where a bridge of 30 feet span will be required.

From Peters' swail, the line runs nearly a west course 2½ miles, through dry, open, cultivated fields, to one of the branches of 11 mile creek, where another bridge of 30 feet span, will be required; thence the line curves slightly to the north, and follows the same broad valley, to the main street in Alden, crossing in its course, two more small branches of 11 mile creek, where I would recommend a bridge to each, of 30 feet span. The line also passes through a number of small patches of timber, of from 2 to 600 feet in extent, that will require grubbing.

The line will enter the main street in the village of Alden, near Bishop's store; thence on the north side of said street to Gage's hotel, in said village. At this point we are 11 miles from Attica, and the line has generally passed over a cultivated and even surface of land, requiring but few excavations, and but very little grubbing.

From Alden to Buffalo, a number of routes present themselves, all feasible, and varying but little in actual cost of construction. The preference to be given one route over another, is the direction and roadway, it being desirable to make the line as short and the right of way as cheap as possible. The one surveyed, was the one from which the least opposition was to be expected from the farming interest, and least claims for damages.

From Buffalo to Alden, the line is 19 miles long, and divided into three straight lines, and two curves; 7½ miles of it upon roads but little used, and scarcely worked—2 miles parallel with the highway, and no buildings to be disturbed—5 miles along the line of lots dividing farms, and the balance of the distance, 4½ miles, through farms where the right of way will have to be purchased.

The line from Alden, follows the old State road as far as it is open; thence entering the woods upon the line of lots, 2½ miles of which is covered with a heavy growth of hemlock and ash; surface soft and swampy, but not deep; the land is easily drained, as it has a descent in the direction of the survey of 30 feet per mile. Thence the line continues through open fields and small pieces of timber, to within one mile of Lancaster, where we are obliged to leave the line of lots and curve to the north, around the village, keeping upon the table land above the Cayuga flats. Thence we run a west course, crossing the Buffalo road in front of Hitchcock's and keeping on the north side of said road to its junction with the Ellicott road; thence on the north side of said road, to Batavia street, in the city of Buffalo.

The soil through this section of country is clay, with the exception of a narrow strip of sand and gravel, of two miles in width, crossing the line after leaving Alden. From appearances, I do not think we shall find a yard of rock excavation on the route; and the entire absence of good building stone, compels me to estimate for wooden culverts and small bridges, which I would not do if good building material was at hand; as there is not a stream upon the whole route but what a 15 foot culvert would be suf-

ficient to carry the water at any time. The most expensive part of this route is the first two miles from Alden, requiring deep excavations and heavy embankments,—the soil in this instance happens to be sand and gravel. The most of the way from Attica to Buffalo, may be an embank ment road, which is preferable, when the soil is principally clay. Embankments are generally harder, and the road is easier drained than excavations, and easier kept open in winter.

All the necessary excavations upon this road I would make 10 feet wider than usual, so as to allow of deep, broad ditches. Experience has proved that effectual draining is of the utmost importance, particularly in excavations, where they are liable to be filled, from slides, and a variety of causes checking the water and softening the road, and continually subjecting the company to heavy expenditures to keep the road in repair. A great proportion of the expense of keeping a road open in the winter, is caused by the difficulty of disposing of the snow in the excavations, which would be in a measure relieved by wide excavations, and entirely so upon an embankment road.

I would not recommend in the first stages of the work, the usual heavy outlays for car houses, shops, or permanent buildings, except water stations, wood houses, etc. It frequently happens that the first location is not the best one. Buildings can be erected after the road is completed, adapted to the business of the road. Neither would I recommend a more expensive outfit than just sufficient to run the road, as it is quite probable an arrangement can be made with the Tonawanda company, to run the road.—Their engines and cars could do the business of both roads, at a small addition to their present expenditures.

The timber upon the line is principally beech, maple, elm, ash and hemlock; some oak, but very little immediately upon the line of the survey. Lands a little south on the reservation, are thickly covered with oak, from which a good supply of ties and rails may be procured. Hemlock sills may be obtainted along the line. The kind of road I would propose here would be of the same pattern as the Utica and Schenectada road, with rather heavier sills, and shorter bearings.

Sizes of Timber.

Sills—5 by 12, 30 feet long—hemlock.
Ties—6 by 6, 8 feet long—white oak.
Rails—6 by 6, 24 feet long—white oak.
Iron—$2\frac{1}{2}$ by $\frac{7}{8}$ inches.

The ties should be procured from young second growth oak, from 8 to 10 inches diameter, and hewn on two sides—if not, take them from trees large enough to quarter, and make them triangular. The sills should be 5 by 12, and 24, 27 and 30 feet long. The rails 6 inches square, 24, 27 and 30 feet long. The iron estimated is heavier than usual. Experience has proved that the usual thickness, $\frac{3}{4}$ of an inch, is too light to keep the superstructure firm and solid, which is more needed upon a clay soil, than a gravel. The following estimate of a single mile, together with the estimate of the whole line, is respectfully submitted.

Estimate a single mile of superstructure.

52,800 ft. hemlock sills, 5 by 8, 30 ft. long, at $8,	$422 40
2,000 ties per mile, 6 by 6, 8 feet long, at 20 cts.	400 00
31,680 ft. white oak rails, 6 by 6, at $15,	475 20
33 tons of iron, per mile, $\frac{7}{8}$ by $2\frac{1}{2}$ in., at $60,	1,980 00
Spikes,	133 00
Wedges,	20 00
Workmanship,	640 00
	$4,070 60

Estimate for a single track railway from Attica to Buffalo.

1st division, from Attica to Alden, 11 miles.

51,657 cubic yds. excavation, at 11 c.		$5,682	27
97,926 do embankment, 14 c.		13,709	64
8,000 do in ditches, 14 c.		1,120	00
2 miles of grubbing, at $800,		1,600	00
			22,111 91

2d division, from Alden to Buffalo, 19 miles.

261,000 cubic yds. embankment, 14c.		$36,540	00
72,620 do excavation, 11c.		7,988	20
15,000 do in ditches, 14c.		2,100	00
2½ miles of grubbing, at $1,000,		2,500	00
			$49,128 20

Bridges, road crossings, etc.

32 small bridges, from 6 to 8 feet, in place of culverts, at $70,			$2,240 00
8 do 10 feet, do at $90,			720, 00
6 do 30 feet span, 500,			3,000 00
1 road bridge,			1,600 00
26 road crossings,	15,		390 00
76 farm crossings,	10,		760 00
36 cattle culverts,	40,		1,440 00
30 miles superstructure,	4,070 60		122,118 00
1 mile of superstructure in 6 turns-out,			4,070 60
12 switches,	110,		1,320 00
Agents, commissioners and preliminary surveys,	$8,000		
Pay of engineers, for 2 years,	15,000		23,000 00

Permanent Buildings.

4 water stations, at	$2,600	
4 wood houses,	2,400	
1 engine house,	3,000	
3 large and 8 small turn tables,	3,100	11,100 00

Temporary Buildings.

2 car houses,	3,000	
1 engine house,	1,200	
1 car house,	1,000	
1 freight house,	900	
1 carpenter's shop,	600	6,700 00
		$249,678 71
Add ten per cent. for contingencies,		24,969 87
		$274,668 58

Outfit,			$274,668 58
3 engines,	$7,000,	$21,000	
8 long passage cars,	1,700,	13,600	
2 post office cars,	620,	1,240	
4 baggage cars,	550,	2,200	
30 freight cars,	290,	8,700	46,740 00
			$321,408 58

Average cost of construction, $10,713 62 per mile, including ontfit.

Estimated expense of southern line, in village of Attica.

46,200 cubic yards of embankment in Tonawanda valley at 20c.	$9,240 00
Bridge across the Tonawanda creek,	3,000 00
½ mile saved in distance, at average of whole,	5,356 81
Cost over north route,	$17,596 81
Whole capital,	350,000 00
Cost of construction,	321,408 58
Amount applicable to settlement of lands and damages,	$28,591 42

All of which is respectfully submitted,

GEORGE RICH, *Engineer.*

Attica, July 1, 1840.

More Locomotives.—The engine "America," for the Worcester railroad, Massachusetts, was shipped yesterday morning; and another for the Memphis and La Grange railroad, Tenessee, is to be shipped in a few days. Both are from Mr. Norris's factory. They have both eight wheels, and are of great power.

TRIUMPH OF STEAM—A RAILROAD TRAIN.—The Boston Daily Advertiser of the 21st instant states that "the eight wheeled locomotive engine America, built by Mr. Norris, of Philadelphia, left Boston on Wednesday for Worcester, with a load of one hundred and fifty tons of merchandize for the purpose of an *experiment* on the Western Railroad, from Worcester to Springfield. The train arrived at Worcester on Wednesday evening. We have not heard of the result on the Western Road. The load consisted of 150 tons nett of merchandize, exclusive of the cars and tender, which must have weighed nearly one hundred tons more."—

This "experiment" is interesting to us New Yorkers, in as much as it presents the fact, that a single locomotive has drawn a gross load of about 250 tons or 150 tons nett from Boston to Worcester, and has no doubt carried it to Springfield over grades of 60 feet. This feat should not leave a doubt, that on the completion of the Western road to Albany, 1000 barrels of flour may be carried in one train. Trains started every half hour, with suitable turn-outs, present the capacity of the "Great Western Railroad," equal to 48,000 barrels of flour per day. An amount greater than can be passed on the Erie Canal during one days lockage.

This experiment induces further reflection "that which has been done, can be performed again." It is, as to the cost of transportation on railways. We find it recorded that one of Mr. Norris' engines drew over the Philadelphia and Reading Railroad, 54 miles, at the rate of ten miles per hour, 101 cars, containing 323 tons nett load, exclusive of cars and tender, at the trifling total expense of $57. This sum included fuel, oil, engineers, four men at the breakes, with $20.20 per diem, allowed for the use of the 101 cars at 20 cents each. It is true this road is nearly level, or descending. It, however, establishes the great power of the locomotive engine, for transportation on a well constructed railway, and there should not be a doubt in our minds, that the Bostonians, at the close of the next season of navigation of our Erie Canal, (1841,) will be able to carry a barrel of flour, the 201 miles, from Albany to Boston, for 25 cents per barrel, with a remunerating profit to the road. This they can do, if one-fourth of the capacity of the road is taxed, and they have the usual travel which so great a thoroughfare promises.

DANGERS OF RAILROAD TRAVELLING.

It is ascertained by experiment, that the danger of loss of life on an average railroad trip, is as about 1 to 4,000,000. The following data on which this conclusion is founded, are copied from a late British publication:

Name of railway.	*No. of miles.*	*No. of passengers.*	*No. of accidents.*
London and Birmingham,	19,119,465	541,360	3 cases of contusion, no deaths, (1)
Grand Junction,	97½*	214,064	2 cases slight do (2)
Bolton & Leigh, and Kenyon and Leigh,	3,923,012	508,763	2 deaths, three slight contusions, (3)
Newcastle and Carlisle,	1*	8,540,759	5 deaths, 4 fractures, (4)
Edinburgh and Dalkeith,	7*	1,557,642	One arm broken,
Stockton & Darlington,	2,213,681	357,205	None,
Great Western,	4,109,538	230,408	None,
Liverpool and Manchester,	30*	3,524,820	Eight deaths, no fractures, (5)
Dublin and Kingston,	1*	26,410,152	5 deaths and contusions to passengers,
London and Greenwich,	484,000	2,880,417	One passenger slightly bruised.

* Length of road.

(1) None of these accidents occurred to actual passengers.

(2) None of these accidents occurred to actual passengers.

(3) None of the persons killed were passengers.

(4) One of the persons killed was a passenger.

(5) The whole of these were passengers; one of them a serjeant in charge of a deserter, who jumped off the carriage whilst in motion; the serjeant jumped after him to re-take him, but was so much injured that he died; three others got out and walked on the road, and were killed; the rest suffered by collisions of two trains, at different times. These include all the casualties from the very commencement of the working of the line.

REPORT OF THE ENGINEER IN CHIEF OF THE GEORGIA RAILROAD AND BANKING CO. TO THE CONVENTION OF STOCKHOLDERS.

ENGINEER DEPARTMENT, GEO. RAILROAD, AND BANKING CO.
Greenesboro', April, 29th, 1840.

To William Dearing, Esq., President Georgia Railroad, and Banking Company:

SIR:—At the period of my last annual Report, a party of my assistants were engaged in making experimental surveys of the country between Yellow river, and the southern terminus of the Western, and Atlantic railroad; having previously completed a preliminary location of the road below that river. These surveys were continued untill the illness of my principal Assistant of location rendered it expedient to disband the party. After carefully collating the information collected by them. I am fully satisfied that the estimate I ventured to make in my report of the cost of this extension ($1,200,000) was sufficiently liberal. If the recent fall in the price of iron is permanent, it will be found to be too high.

In conformity with a resolution of the Board, in February last; the lo-

cation has been again resumed, and a revision of that part of the line crossing the Alcovy river, already made. Although we have been unable to effect any great saving in the amount of work to be executed on this difficult division of our route, yet we have succeeded in obtaining a line free from soil of uncertain character.

The preliminary location of the road has now advanced to a point nearly opposite the Stone Mountain, and will be continued thence along the course of the ridge parting the waters of South river from those of Yellow and Chattahochee rivers, to the Western, and Atlantic railroad. Other lines will also be traced with a view of obtaining a route which will afford the greatest facilities for a connexion ultimately with West Point.

As soon as the final location has been made of the whole line, I will prepare a detailed estimate of the cost of the work, and report to the Board the result. In anticipation of meeting with much rock excavation, I have taken measures to have each cut bored, that an estimate may be presented that can be fully relied on.

The graduation and bridging of the Madison Branch, with an immaterial exception, is now finished. Upon the Athens Branch, there remains about five miles to be completed—two of which have not yet been commenced—the whole will be prepared during the ensuing summer, or fall. The cost of grading unfinished on both branches, is estimated at $33,027 00.

A contract for laying the superstructure of the Madison Branch, was entered into in July, 1839, with Weaver & Co.; the whole to have been completed in March last, but owing to the low stage of the river, when our iron arrived at Savannah, and the continued drought during the entire summer and fall, we were unable to deliver them the necessary materials to commence operations with until December. As this was the most unpropitous season possible to procure labor, but little was done before the middle of January; since that time the work has progressed very satisfactorily. In one or two weeks we shall cross the Oconee river; and I entertain no fears of being able to reach our depot near Madison, in ample time for the next crop.

Our order for iron for the Madison Branch, was 1800 tons, of this amount I have been advised of the receipt of 1,757½ tons. In addition to this, I understand that about 24 tons were shipped by the Governor Troup, making a total of 1,781½ tons, leaving a deficiency of 18½ tons. In consequence of this deficiency, together with the increased size of the bar received over the specifications sent (a liberty which manufacturers frequently lake when an agent of the company is not present) our iron will not reach the point designated for the terminus of the road in Madison. We shall, therefore, be under the necessity of transacting our business this year about 1½ miles below the town, on property belonging to the company. While this arrangement will deprive us for a time of some of the conveniences of a nearer location to the village; the disadvantages arising from it, will be fully counterbalanced by the ample space we shall have for transacting our business, which could not be obtained in the town without a resort to considerable expense.

The amount necessary to complete the superstructure of the Madison branch, including the sum required for iron, cross ties, and mud sills, is estimated at $37,916 00.

Twelve miles of the superstructure of the Athens branch will be finished this season, if the iron arrives in time. The remainder can be completed during the ensuing year. The iron on hand will extend about 7 miles. The additional order sent forward will enable us to reach a short

distance above the Washington, and Athens road, leaving a distance of 12 miles to be provided for. The amount necessary to complete the superstructure of this branch is estimated at $196,596 00. If we add to this the estimate for completing the superstructure of the Madison branch, and the cost of grading yet unpaid, we shall have the whole amount required for road construction $266,539 00. This includes all work done upon which an estimate has not been returned. In addition to the above, we shall require for the construction of cars, depot, and passenger office at Augusta, about $26,000 00.

Our present motive power, it is believed, will be sufficient to do the business of the road for the ensuing year.

The length of road in use (including the 3½ miles of branch road to Warrenton) for the past year has been 88 miles. The cost of repairs, and police for this distance, you will perceive by reference to the accompanying statement marked No. 9, is $17,170 75-100 for the eleven months, ending on the 31st ult., or at the rate of $195 per mile.

If we take into consideration the high price paid for labor, and provisions, this result must be considered very gratifying. Upon the Richmond, and Fredericksburg railroad, a work which went into operation about a year before ours, the cost of repairs of road according to the last annual report of that company was $927 per mile for eleven months—on the Roanoke, and Petersburg railroad, the annual cost of repairs are stated by H. D. Bird, Esq., engineer and president of the company, to vary from $550 to $750 per mile per annum. These roads are constructed with the ordinary flat bar of ¼ inch in thickness. Our iron for 79 miles, you are aware is of the same description, but heavier, being $2\frac{1}{16} \times \frac{3}{16}$ inches. On the remaining distance the inverted T rail is used, the maintenance of which has not exceeded $75 per mile.

We have now given the expense of maintaining our road, and those of like construction but of lighter iron, where labor is 70 per cent. cheaper than it is with us. The roads referred to have been selected, because we have not had access to the statements of any other companies on which the plate rail is used. If we take the three principal roads of New England, which are constructed with heavy iron edge rails in the best manner, the comparison will still exhibit our expenditures in a favorable light. On the Boston, and Lowell railroad, the annual expense of maintaining the road last year, was $731 per mile; Boston, and Providence, $209; and Boston, and Worcester, $405. It is also to be recollected, that our passenger train traverses the road in both directions after night, which adds considerably to the expense of its maintenance. This is not the case on either of the works referred to, except the Richmond, and Fredericksburg railroad.

If either of the items of our current expenses is compared with the published reports of other companies, we shall find the same favorable result. We have entered into these comparisons for the purpose of showing to the stockholders, that as large as our expenses may seem to them, they are not greater than those of other railroad companies, who are much better situated for procuring labor, and materials on favorable terms. For instance, our iron used in the shops, costs us in consequence of the difference of freight, about 25 per cent. more than it would at the north, and our enginemen, and machinists, and blacksmiths are paid from 50 to 100 per cent. higher wages.

The motive power department has been re-organised since my last report with evident advantage to the company. The work done in the shops is greater than it was last year, and with a less amount of labor.

The engines have been kept in excellent order, and have never failed to perform the duties required of them on the road. Two new locomotives, and three tenders have been added to our machinery during the year, making the whole number of engines, twelve, all of which are in good order, or can be placed so in a few days, except the Georgia; the latter engine is undergoing a thorough repair; when completed she will be fully as valuable a machine as when placed on the road. I refer you to the accompanying document, No. 9, for a statement of the expenses of motive power, and to No. 10, for a detailed statement of the repairs of each engine, and the distance run in miles,

During the prevalence of the epidemic in Augusta last fall, our machine shop was maintained at a considerably increased expense relatively. The cost of the work done in consequence, was much enhanced, which being charged to the several accounts at the usual rates has left a ballance against the shop. This amount is added to the current expenses under the head of loss from contingencies. For a statement of the business of the machine shop and car factory, I refer you to documents No. 11, and No. 12.

The business of the road is exhibited in detail in documents, Nos. 1, 2, 3, 4, and 5. In Nos. 6, 7, and 8, the same is shown in a more condensed form. The following statement gives a general view of the receipts and disbursements on account of the business of the road for the eleven months ending on the 31st of March, to which period the accounts have been made up to correspond more nearly in time with those of the bank.

Business of the Georgia Railroad—eleven months.

Dr.	To expenses of conducting transportation,		$21,969 33
	" " " Motive power,		26,141 22
	" " " Maintenance of way,		17,170 79
	" " " " " Cars		4,965 00
		Total,	$70,246 34
Cr.	By amount received for Freight,		$101,420 25
	" " " " Passengers,		63,505 21
	" " " " Mail,		17,940 81
	" " " " Miscellaneous,		1,737 27
		Total,	$184,603 54

In comparing the several statements in relation to the business of the road with those furnished last year, you will perceive that there has been a falling off in the number of passengers in the corresponding months amounting to 3,806, while our expenses in this branch of our transportation have been considerably increased by a contract with the post office department for carrying the great northern and southern mail in both directions after night, and the maintenance of a tri-weekly day line for the accommodation of those who are unwilling to venture in the mail train. We were induced to enter into this arrangement for the purpose of expediting the mail, and travel between the North, and South, believing it to be our duty, occupying as we do, a portion of the great thoroughfare connecting these extremes of the Union, to yield our preferences as to time to those of the public good and convenience.

The compensation we receive from the department, however, for this extraordinary service, repays us but very inadequately, for the additional risk, and expense encountered. The Post Master General, by a singu-

lar construction of the law of congress, limiting the terms he should grant railroad companies, has fixed the maximum rate of compensation for mail service at $237 50-100 per mile, and has offered this sum to all companies that have surrendered to him the control of their hours of arrival, and departure, without admitting any difference of compensation whether the service was to be performed by night, or by day. The injustice of this decision is so apparent to those at all acquainted with railroad transportation, that it is a matter of surprise that it has been maintained. If the low amount which will be paid under this construction of the law to the several railroads between this place, and New York, have been distributed among the companies upon equitable principles, having reference to the hours the service is performed, I have no doubt general satisfaction would have been given to all parties.

In our contract I succeeded in making arrangements for the transportation of the mail over the whole length of our road, and to be extended as the work advances—it having previously left the line at Warrenton. If this object had not been yielded to us, we could not, with a due regard to the interests of the company, have acceded to the onerous conditions imposed.

We have thus far been peculiarly fortunate with the night line, having met with no accident of importance during the 10 months we have been running. Our mail failures in both directions have only been seven, three of which were occasioned by heavy sleet on the rails, preventing the adhesion of the driving wheels of the locomotive, and of course the progress of the train.

The decrease in the number of passengers already alluded to may be partly accounted for by the prevalence of the epidemic in Augusta, and the removal of the Florida line of stages from the head of the road. But it is mainly to be attributed to the derangement of the monetary affairs of the country, and consequent depression in business of all kinds, which also satisfactorily accounts for the diminution in the amount of up freight during the months of February and March last.

The Florida line of stages, after an ineffectual attempt to divert the current of travel from our road to the route via Brunswick and Tallahassee to Mobile, has again resumed its regular trips from this place to Bainbridge on Flint river, where the passengers now take steamboat.

In the aggregate our business for the eleven months shows an increase over the whole of last year of $49,873 12-100 while our expenditures have only been increased $6,884 20-100. A much larger amount of business in up freight and passengers could have been done without adding to our expenses.

Our nett profits on the road, and machinery in use which is estimated at $1,300,000, is nearly 10 per cent. per annum.

For the favorable exhibit we are enabled to make of the year's operations, the company are much indebted to the Superintendant of transportation and Assistant Gen. Agent, Richard Peters, jr. The able and efficient manner he has fulfilled the duties of the department under his immediate control, and seconded me in all the operations connected with the finished road, render this acknowledgment of his services an act both of duty and pleasure.

As the rates established by our charter for the conveyance of passengers, yields the company an inadequate compensation for the expenditures, on this branch of their business, I would respectfully suggest to the board the propriety of an application to the next Legislature, for, either an increase of the rates, or a removal of the res-

triction altogether, as has been done in the charters of the other railroad companies of this State. I cannot see that any reasonable objection can be urged to this request, especially as it would enable the company to reduce their charge on freight, which is paid almost exclusively by citizens of Georgia, while scarcely one half of the passengers are residents of the State. But apart from these considerations, it is unquestionably the true policy of the company and their customers to make each branch of the business bear its due proportion of the burdens. Our charges for passengers are now 30 per cent. below those of the railroad companies in Virginia, and at the North generally, where nearly all the elements of the cost of transportation ought to be less than with us, and 50 per cent. lower than the rates of the S. C. C. and R. R. Co. The rates fixed by our charter for freight are sufficiently high in the aggregate. But even in this branch of our business the company might, if not so narrowly restricted, establish a tariff of prices more in conformity with the laws of trade, and much more satisfactory and beneficial to the community who make use of the facilities afforded by the improvement.

In conclusion, I will observe that the result of our last year's business has greatly strengthened my faith in the profitableness of railroads. The nett revenue on our whole expenditure, about $700,000 of which is dead capital, is at the rate of 6 per cent. per annum, notwithstanding our low charges for passage, and the general stagnation of the business of the country. I can now state with confidence that wherever the transportation is of a mixed character, such as agricultural products, general merchandize, and passengers, and sufficiently large to justify the construction of a *good road*, railroads will be found to be not only the most expeditious, but the cheapest artificial medium of conveyance at present known.

A certain quantity of business at our rates is required to defray the cost transportation, and all above this amount, deducting merely a small portion for additional current expenses, will be the profits on the capital invested, and as this capital remains nearly the same for a large or small business, it is evident that the revenue of the company is increased in proportion as the business is enlarged above this point. It is mainly in view of this fact that I have so earnestly urged upon the board the importance of continuing our road to the Western, and Atlantic railroad, thereby directly connecting it on the one hand with the navigable waters of the West, and on the other, through the Hiwassee railroad with the heart of the rich valley watered by the Tennessee river.

The increase in our business from these sources, especially during the winter, and part of the spring, when the Northern channels are closed by ice, will exceed our most sanguine anticipations.

Goods have already been forwarded from this place to points in Tennessee, beyond the Cumberland Mountain under all the disadvantages of wagon transportation of upwards of 250 miles.

This shows that no effort on our part, other than the completion of our road, will be required to divert the trade of a large portion of the West from its old channels. The greater facilities afforded at the southern terminus of our road for distributing the heavy produce of this region to the various marts on the Atlantic sea board, must secure to us the chief part of its transportation.

Respectfully submitted,

J. Edgar Thompson,
Chief Engineer, and General Agent.